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14. ABSTRACT

Traumatic brain injury (TBI) is considered one of the signature wounds of the current conflicts in Iraq and Afghanistan. Compared to previous wars and because of advancements in battlefield medical care and personal protective equipment, many casualties survive these wounds and are returned to duty. However, those service members who return to duty following mild TBI, or concussion, are at risk for repeated injury. The effects of repeated TBI among U.S. service members have not been examined. This study for the first time described the occurrence of repeated TBI among military deployed personnel, and identified time between repeated TBI events. The median time between repeated TBI events was 40 days. Severity of the 2nd event, but not 1st event, was predictive of adverse neurological and psychological outcomes. Results of the aforementioned analysis have been published in the Journal of Rehabilitation Research and Development (MacGregor, 2011). An analysis is currently underway that is examining repeated TBI events compared with single TBI events and an injured, non-TBI control group. The results of this study may have a direct impact on military policy, as guidelines are currently being considered to address the management of combat-related TBI.

15. SUBJECT TERMS
TBI, repeated, neurological, psychological, military, combat

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INTRODUCTION

Traumatic brain injury (TBI), or concussion, is considered one of the signature wounds of the current conflicts in Iraq and Afghanistan. Compared to previous wars and because of advancements in battlefield medical care and personal protective equipment, many casualties survive these wounds and are returned to duty. However, those service members who return to duty following mild TBI are at risk for repeated injury. In civilians, especially athletes, repeated TBI is associated with adverse outcomes, such as dementia. The effects of repeated TBI among U.S. service members have not been examined. This study examined repeated TBI using medical records collected near the point of injury in Iraq, which also allowed for calculation of time between TBI events. The results of this study may have a direct impact on military policy, as guidelines are currently being considered to address the management of combat-related TBI. For the purposes of the remainder of this report, TBI will be used interchangeably with concussion.

BODY (Please refer to the Appendix: MacGregor, 2011, to find the published article that is referred to below)

Specific Aim #1: Define the demographic and injury specific characteristics of repeated traumatic brain injury (TBI) during Operation Iraqi Freedom (OIF).

Task 1. Data extraction from multiple existing data sources to assemble the repeated TBI cohort and define individual personnel characteristics. (months 1-2)
1a. Identify personnel from the Tri-Service Navy-Marine Corps Combat Trauma Registry Expeditionary Medical Encounter Database (Navy-Marine Corps CTR EMED) with more than one clinically diagnosed TBI during OIF. (month 1)
1b. Link injured personnel with Defense Manpower Data Center and DEERS information for demographic and deployment-specific variables. (month 2)

Update: This task has been completed. The final study population consisted of 113 individuals with repeated TBI. The results were published recently (MacGregor, 2011).

Task 2. Identify correlates of increased severity of second TBI event. (month 3)
2a. Identify severity of each individual TBI event. (month 3)
2b. Calculate time between TBI events for all personnel with repeated TBI. (month 3)
2c. Identify disposition (i.e. returned to duty, light duty, evacuated, etc.) for all personnel with repeated TBI. (month 3)

Update: This task has been completed, and the results were recently published (MacGregor, 2011). Severity of 2nd event was a predictor of mental and neurological outcomes, but severity of 1st event was not associated. Severity of 1st event was not associated with severity of 2nd event.

Task 3. Assess occupational risk of repeated TBI. (month 4)
3a. Select representative sample of single TBI events from Navy-Marine Corps CTR EMED. (month 4)
3b. Compare Military Occupational Specialties utilizing chi-square statistics. (month 4)

Update: Analysis for this task is currently underway. The cohort of single and repeated TBI events has been identified, and the analysis has begun.

Task 4. Prepare manuscript for publication encompassing specific aim #1. (months 5-6)
4a. Complete manuscript draft. (month 5)
4b. Edit and format per journal requirements. (months 5-6)
4c. Submit for release authority through public affairs office. (month 6)

Update: This task has been completed with the exception of task 4 (MacGregor, 2011). The results of this task will be published in the 2nd manuscript on specific aim 2.

Specific Aim #2: Identify health care utilization, mental health outcomes and attrition rates among those with repeated TBI and compare with multiple injured control groups.

Task 1. Data extraction from multiple existing data sources to assemble the injured control groups. (months 7-8)
1a. Identify control group A from the Navy-Marine CTR EMED; personnel with one non-TBI event and a subsequent TBI event. (month 7)
1b. Identify control group B from the Navy-Marine CTR EMED; personnel with two non-TBI events. (month 7)
1c. Link injured personnel with Defense Manpower Data Center and DEERS information for demographic and deployment-specific variables. (month 8)

Update: This task has been completed. The single and repeated TBI cohort has been identified. Additionally, an injured control group of non-head injuries has also been identified. Data analysis has begun.

Task 2. Identify post-injury medical utilization using Military Health System records. (months 9-12)
2a. Identify specific number of general inpatient and outpatient health care visits for the study population. (months 9-10)
2b. Identify specific number of mental health inpatient and outpatient health care visits for the study population. (months 10-11)
2c. Identify specific inpatient and outpatient mental health diagnoses for the study population and group into categories (i.e. anxiety, mood, adjustment, and substance abuse disorders). (months 11-12)

Update: This task is currently underway, data analysis has begun on the study population.

Task 3. Utilize regression modeling to assess relationship between repeated TBI and subsequent health outcomes. (months 12-14)
3a. Utilize regression techniques for analysis of general and mental health care visits. (months 12-13)
3b. Utilize regression techniques for analysis of mental health diagnoses. (month 13)
3c. Utilize regression techniques for analysis of military attrition. (month 14)
3d. Repeat regression analyses following adjustment for potential confounding demographic and injury specific variables. (months 13-14)

Update: This task is currently underway, data analysis has begun on the study population.

Specific Aim #3: Examine the potential protective effect of time between TBI events.

Task 1. Repeat regression analyses outlined in specific aim #2, task 3. (months 15-16)
1a. Utilize the time between TBI events as both a continuous and categorical variable. (months 15-16)
1b. Assess any interaction with disposition following TBI events. (months 15-16)

Update: This task has not yet been initiated, as data analysis for previous tasks is still underway. However, time was examined for its potential protective effect on severity of 2nd event. There was no association, and this is included in the manuscript that was recently published (MacGregor, 2011).

Task 2. Prepare manuscript for publication encompassing specific aims #1 and #2. (months 16-18)
2a. Complete manuscript draft. (months 16-17)
2b. Edit and format per journal requirements. (months 17-18)
2c. Submit for release authority through public affairs office. (month 18)

Update: This task has not yet been initiated, as data analysis is still underway. However the literature review has been continually updated, and many of the methods for the first published manuscript carry over to this one (MacGregor, 2011).

KEY RESEARCH ACCOMPLISHMENTS

- First study to examine repeated TBI in deployed military personnel
- Added to the literature on the effects of time between repeated TBI events, a subject sparsely researched even in the civilian community
- Identified future areas of research to further knowledge on repeated TBI

REPORTABLE OUTCOMES

MacGregor AJ, Dougherty AL, Morrison RA, Quinn KH, Galarneau MR. Repeated concussion among U.S. military personnel during Operation Iraqi Freedom. In Press, Journal of Rehabilitation Research and Development.

MacGregor AJ, Morrison RH, Dougherty AL, Galarneau MR, Mayo JM. Repeated traumatic brain injury: Are military personnel a high risk occupational group? Poster presented at the Forty-Ninth Navy and Marine Corps Public Health Conference, Hampton, Virginia, March 2010.

CONCLUSIONS

More research is needed to examine the cumulative effects, if any, of repeated concussion among military personnel. The first published article from this research (MacGregor, 2011) is the initial investigation of the topic and is mostly descriptive in nature. No effect of severity of the 1st TBI event was found. This may have been due to small sample size, however. Severity of the 2nd TBI event was predictive of adverse psychological and neurological outcome. The median time between TBI events was 40 days, but time was not associated with poor outcome. The analysis that is currently underway will add to the body of literature by bringing in single TBI events and non-head injuries as comparison groups. Future studies should prospectively examine repeated TBI in a large cohort of military personnel in order to maximize sample size. The final results of the present analysis will advance discussion on future military TBI policies, to include restriction from duty following a certain number of TBI events.

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APPENDIX

MacGregor AJ, Dougherty AL, Morrison RH, Quinn KH, Galarneau MR. Repeated concussion among U.S. military personnel during Operation Iraqi Freedom. J Rehabil Res Dev. 2011;48(10):1269-78. Available at: http://www.rehab.research.va.gov/jour/11/4810/pdf/macgregor4810.pdf